

Title of the Invention: ELECTRIC MOTOR AND GENERATOR

Background of the Invention:

<Technical Field>

5 The present invention relates to an electric motor and  
a generator or an electric drive and power generation system  
in which a power generation is carried out in a power source  
such as an electric motor, an internal combustion engine, a wind  
power, a hydraulic power and a human power using an apparatus  
10 and machine.

<Prior Art>

In generally, an ordinary electric power such as a  
rotating machine, a pump and a blower etc. are driven with a  
single function. For example, the pump is used merely in a  
15 transportation of fluid, the blower is used merely to send the  
air. The electric motor used as the electric power is not  
utilized in real as a power generation.

Summary of the Invention:

20 An object of the present invention is to provide an  
electric motor and a generator or an electric drive and a power  
generation system wherein by applying a power single function  
electric motor, the electric motor, an internal combustion  
engine and a wind power or a hydraulic power from  
25 outside portion is utilized, thereby a power generation  
function can be obtained.

Another object of the present invention is to provide an

electric motor and a generator or an electric drive and a power generation system wherein in a case in which an electric motor is utilized as a power generation single function, a raise-up to a power generation function can be carried out smoothly and further in a case of an electric motor and generator complex function an economic system suited for an operation control such as a mutual change-over between a single or plural electric motors and generators can be obtained.

A further object of the present invention is to provide an electric motor and a generator or an electric drive and a power generation system wherein in a case of a system for applying a fluid machinery, an exchange-over of an electric drive and a power generation can be carried out only by altering a mechanical structure such as a blade and a fluid transportation mechanism without an alternation of an electric control line system.

A further object of the present invention is to provide an electric motor and a generator or an electric drive and a power generation system wherein in a case of a system for applying a fluid machinery, an exchange-over of an electric drive and a power generation can be realized only by an electric control without an alternation of a mechanical structure system.

According to the present invention, in an electric motor and a generator which is constituted using the electric motor as a power source and is used in an electric power line, an electric drive generator is provided integrally or is provided

separately, thereby a power generation function is obtained.

According to the present invention, in an electric motor and a generator, in a case of a power generation function, the generator is activated and is risen up near to a synchronous speed and the generator is carried out a switch-on operation; in a case of an electric power generation function, the electric motor is made once in non-load condition and is activated and is risen up near once to a synchronous speed from a stop condition and the generator is carried out a switch-on operation; and thereby an induction motor excited on an electric power system line or an alternating current is constituted.

According to the present invention, in a fluid machinery having a blade or a water turbine and a rotating machine, in a case of a propelling machine, a twist angle is made reversal, and in a case of a centrifugal machine, an intake port of the fluid is changed over from an air inhale side to an air exhaust side; thereby without an alternation of a control circuit, a fluid transportation function is changed over to a power generation system.

According to the present invention, in an electric motor and a generator which is constituted using the electric motor as a power source and is used in an electric power line, in every case of a power generation function and a complex function of the electric motor and the generator, when a stop or a power function is changed over to a power generation system, data necessary to control a load condition, an outside portion power condition, a power condition of an outside generator etc. are

5           According to the present invention, in a wind power  
generation system having an electric motor and a generator for  
sending air using a blade and for carrying out a wind power  
generation by taking air into from all direction, a wind  
direction guide is installed; and an induction motor is  
10       constituted as a main electric machine.

20           According to the present invention, in a fluid power  
generation system having a fluid machine constituted by a blade,  
a water turbine and a rotating machine, and having an electric  
motor and a generator, in a case of a single power generation  
function, the system is activated as the electric motor and the  
25   electric motor is risen up near to a synchronous speed; and in  
a case of a complex function of the electric motor and the  
generator, a rotation magnetic field is varied electrically,

and the system is activated as the electric motor and the electric motor is risen up near to a synchronous speed.

According to the present invention, in a rotating machine having a stator and a rotor, a single conductive member or plural  
5 conductive members are provided with a sandwich shape in a laminated iron core; and on an outer peripheral portion of the conductive member, a groove is provided to not flow current shortly between rotor bars.

According to the present invention, in a rotating machine  
10 having a stator and a rotor, a single disc member or plural disc member are provided in a laminated iron core of the rotor; and the laminated iron core of the rotor is projected from an axial direction length of an iron core of the stator.

According to the present invention, in a rotating machine,  
15 an extension portion of a rotor bar is formed on an outer peripheral portion of an end ring; thereby a magnetic field of an overhang portion of the laminated iron core of the rotor is formed validly.

20 Brief Description of Drawing:

Fig. 1 is an explanatory view showing one embodiment of an electric motor and a generator or an electric drive and power generation system according to the present invention and an explanatory view showing of an electric drive system in which  
25 an electric drive is mainly according to the prior art;

Fig. 2 is an explanatory view showing one embodiment of an induction motor for simplifying the electric motor and the

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generator system or the electric drive and power generation system according to the present invention and an explanatory view showing the electric drive system using an induction motor in which the electric drive is mainly according to the prior art;

Fig. 3 is an explanatory view showing an application example to a generator of a fluid machinery represented by a blower or a pump;

Fig. 4 is an explanatory view showing an electric motor and a generator using plural fluid machinery according to the present invention and using sensor groups for detecting such as a flow velocity and temperature a respective operation condition is grasped and controlled;

Fig. 5 is an explanatory view showing an electric motor and a generator according to the present invention in which the electric motor and the generator are installed at a place where an electric power line is not provided;

Fig. 6 is an explanatory view showing an air acceleration element of a magnet according to the present invention;

Fig. 7 is an explanatory view showing a wind power generator for taking air from a whole periphery and for carrying out a power generation according to the present invention;

Fig. 8 is an explanatory view showing a rotor structure of a rotating machine according to the present invention and is an explanatory view showing a rotor structure of a rotating machine according to the prior art;

Fig. 9 is an explanatory view showing an inner conductive

member and an outer conductive member of a rotor structure of a rotating machine according to the present invention;

Fig. 10 is an explanatory view showing a combination of a winding type conductive member and a cage type conductive member according to the present invention;

Fig. 11 is an explanatory view showing a divided iron core structure for increasing centrifugal force according to the present invention;

Fig. 12 is various characteristic view showing an induction generator according to the present invention;

Fig. 13 is an explanatory view showing an effect in a case where a rotor iron core is projected or over-hung from a stator iron core according to the present invention;

Fig. 14 is an explanatory view showing an effect in a case where a stator iron core is projected or over-hung from a rotor iron core according to the present invention;

Fig. 15 is an explanatory view showing an improvement example of a rotating machine having a slot-less iron core according to the present invention;

Fig. 16 is a structural view showing a generator in which a rotor is formed by extending a magnet or an electromagnet in an axial direction according to the present invention and is a structural view showing a generator according to the prior art;

Fig. 17 is a cross-sectional explanatory view showing a magnet type rotor of an outer-rotor type generator according to the present invention and six embodiments are shown in an

explanatory view of a magnetic flux of an air gap;

Fig. 18 is a cross-sectional explanatory view showing a magnet type rotor of an inner-rotor type generator according to the present invention and six embodiments are shown in an explanatory view of a magnetic flux of an air gap;

Fig. 19 is a view showing a divided iron core structure of a magnet type rotor of an outer-rotor generator according to the present invention;

Fig. 20 is a view showing a divided iron core structure  
10 of a cage type rotor of an outer-rotor generator according to  
the present invention;

Fig. 21 is a view showing a divided iron core structure of a magnet type rotor of an outer-rotor generator according to the present invention and the magnet is arranged on a solid  
15 face of the divided iron core;

Fig. 22 is an explanatory view showing a two-pole magnetic pole electromagnet having a donut structure enable to combine with another magnet according to the present invention;

Fig. 23 is an explanatory view showing a six-pole magnetic pole electromagnet having a donut structure enable to combine with another magnet according to the present invention;

Fig. 24 is an explanatory view showing a combination example of four kind electromagnets and two kind magnets of a rotor of a six-pole rotating machine to understand the combination example of the magnet and the electromagnet according to the present invention;

Fig. 25 is an explanatory view showing a combination



example of a magnet and an electromagnet in an inner-rotor type according to the present invention;

Fig. 26 is an explanatory view showing a combination example of a magnet and an electromagnet in an outer-rotor type according to the present invention;

Fig. 27 is a view showing a stator of a three-phase two-pole motor using three inner -outer periphery magnetic pole type electromagnets according to the present invention;

Fig. 28 is a view showing a stator of a three-phase six-pole motor using three inner -outer periphery magnetic pole type electromagnets according to the present invention;

Fig. 29 is an explanatory view showing a structure of a two-pole electromagnet iron core according to the present invention; and

Fig. 30 is an explanatory view showing an iron core structure for lessening an eddy current loss of an alternating current electromagnet according to the present invention.

#### Description of the Invention:

Hereinafter, one embodiment of an electric motor and a generator or an electric drive and power generation system according to the present invention will be explained referring to the drawings. Fig. 1 is a comparison explanatory view of an electric drive system in which an the electric drive is mainly according to the prior art and an electric motor and a generator or an electric drive and power generation system according to the present invention. Fig. 1A is an explanatory view showing

the system according to the prior art and electric motor 10 and 10a connected to an electric power line 1 are applied to and the system is used to a power for a machine tool 20 and a compressor 21. As stated in above, in the job sites such as works and a consumer, the electric motor is used generally as a mere power. The electric motors 10 and 10a, the machine tool 20 and the compressor 21 are controlled by control board 30 and 30a.

On the other hand, the electric motor and the generator or the electric drive and power generation system according to the present invention, as shown in Fig. 1B, an electric motor having utilized merely as a power in the prior art is utilized as a generator by adding a prime mover in an outside portion or by replacing with an integral electric drive generator, and according to the present invention an electric drive and power generation system can be obtained. In a case where the electricity generated by the power generation system of the electric motor according to the prior art is short, a new generator monopoly use internal combustion engine 40a, generators 10b, 10c connected to an electric motor 11a can be added.

To an outside portion of the electric motors 10 and 10a connected to the electric power line 1 the internal combustion engine 40 as the prime mover and the electric motor 11 are added, and the electric motors 10 and 10b having used as the electric motor in the prior system are used as the generators 10' and 10a'. These apparatuses are controlled by control board 30b

and 30c. The newly added generators 10b and 10c are controlled by control boards 30d and 30e. A condenser 60 is provided to accumulate surplus electric power to perform the electric power supplement and the take-in and the take-out of the electric power can be carried out between this condenser 60 and the electric power line 1 through an inverter 50.

Fig. 2 is an explanatory view showing an example of the system of the electric motor which is constituted with an induction motor to constitute simply the system explained with Fig. 1. Fig. 2A is an explanatory view a system according to the prior art and induction motors 12, 12a and 12b connected to an electric power line 1a are applied to. By representing as a fluid machinery to the induction motor 12 a blower having blades 70 is installed and is operated as the blower and the induction motors 12a and 12b are used as a power for a pump hydraulic turbine 22 and a compressor 23. As stated in above, in the job sites such as works and a consumer, the electric motor is used generally as a merely power. The induction motors 12, 12a and 12b, the pump hydraulic turbine 22 and the compressor 23 are controlled by control boards 31, 31a and 31b.

On the other hand, in the electric drive and power generation system according to the present invention shown in Fig. 2B, in the prior art the system is operated as the blower in which the blades 70 are installed to the induction motor 12. However, according to the present invention, only by altering electric circuits, it utilizes as a generator 12' or to the generator 12' is formed as a power using water etc. from an

outside portion, or by replacing it with an integral type electric and power generator 13, accordingly the system is utilized as the generator. According to the present invention an electric drive and power generation system can be obtained.

5 In a case where the electricity generated by the electric  
motors 12', 12a' and 13 according to the prior art is short,  
a new generator monopoly internal combustion engine 41a,  
generators 12c, 12d and 12f driven by an electric motor 12e and  
a human power 28 can be added. The generators 12', 12a' and  
10 13 are controlled by control boards 31c, 31d and 31e. The newly  
added generators 10b and 10c are controlled by control board  
31f, 31g and 31h. An energy accumulation unit 61 such as a  
condenser 61 is provided to accumulate surplus electric power  
to perform the electric power supplement and the take-in and  
15 the take-out of the electric power can be carried out between  
this condenser 61 and the electric power line 1a through an  
inverter 51.

In a case where the induction motor is utilized as the generator, in the induction motor and a asynchronous generator a rotor for suited to the control can be formed with a winding type rotor and a deep groove type rotor.

Fig. 3 is an explanatory view of an example of a generator applied to a fluid machinery which is represented by a blower and a pump etc.. Fig. 3A1 and Fig. 3A2 shows cases in which  
25 the system is operated as the blower. The blower is connected to an electric power line 1b and is constituted by blades 71 and an electric motor 14. The electric motor 14 is made to be

rotated the blades 71 by a control board 32 and the wind is flown out in an arrow direction shown in the figures. Fig. 3A2 is a cross-sectional view which is developed by cross-sectioning a circular periphery in some radial portion from a rotation center of the blade 71. Since the blade is rotated in a black arrow mark rotation direction, the wind is sent out in the arrow direction.

In Fig. 3B1 and Fig. 3B2, a mechanical alternation of the blade 71 etc. of the blower shown in Fig. 3A1 and Fig. 3A2 is not carried out wholly but an electric alternation is carried out. From the electric viewpoint, in a case of a multi-phase rotating machine a phase order is altered and a case of a single-phase rotating machine a polarity characteristic of a main winding is altered and the rotation direction of the blower is changed and then a reverse outside wind is received and the power generation is carried out.

In this case, even with small outside wind to carry out the power generation, the rotation number of the electric motor 14a is risen near to a synchronous speed and the power generation is carried out with the large rotation number being suited to the wind power larger than the synchronous speed. The voltage is one of the electric power line 1b and the current being suited to the electricity generated is supplied to the electric power line 1b. A control of this blower is carried out using a control board 32a. Fig. 3B2 shows a cross-section of the blade 71 which is the entire same one shown in Fig. 2A2.

In Fig. 3C1 and Fig. 3C2, an electrical circuit

alternation of the blade 71 etc. of the blower shown in Fig. 3A1 and Fig. 3A2 is not carried out wholly but a mechanical alternation is carried out. From the mechanical viewpoint, a blade 71a which has a reversal twist angle of the blade 71 etc. and in a case of a centrifugal blade only a mechanical alternation such as a flow passage is carried out and then receiving the reversal wind to the wind sending direction the power generation is carried out.

In this case, even with small outside wind to carry out the power generation, the rotation number of the electric motor 14b is risen near to a synchronous speed and the power generation is carried out with the large rotation number being suited to the wind power larger than the synchronous speed. The voltage is one of the electric power line 1b and the current being suited to the electricity generated is supplied to the electric power line 1b. A control of this blower is carried out using the control board 32b. Fig. 3C2 shows a cross-section of the blade 71a which has the entire reversal twist angle shown in Fig. 3A2.

Fig. 4A and Fig. 4B show the systems among the electric drive and power generation systems using the plural fluid machinery according to the present invention. The electric drive condition, the power generation condition, the load condition and the environment condition are picked up or grasped according to the various kind sensors 91, 91a and 91b, then the operation condition is grasped and further using central controllers 82 and 83 a whole system control is carried out, as a result an effective operation can be carried out.

Fig. 4Aa shows an example of the system in which the electric drive generation is changed over at the same time in the whole system and Fig. 4Ab shows an example of the system among the total number of the blowers in the electric drive generation system the respective operation number of the power generation or the electric drive is determined, at the same time the complex operation of the power generation and the electric drive is carried out.

In Fig. 4A and Fig. 4B, reference numerals 17, 17a and 17b indicated electric drive generators, reference numerals 72, 72a and 72b indicate blades, reference numerals 34, 34a, 34b, 34c, 34d, 34e indicate control boards for controlling the respective blowers. A reference numeral 63 indicates an energy accumulation unit such a condenser and a reference numeral 53 indicate an energy conversion unit such as an inverter.

Fig. 5 is an explanatory view showing an example of a case where the electric drive and power generation system according to the present invention is constituted in a place having no electric power line and a transportation facility such an automobile and the voltage and the frequency of the electric power line 1d can be selected a most suited one for the system. As the power supply for supplying the electric power to the electric power line 1d there are the energy accumulation unit 64 and the inverter 54 and the alternating synchronous generator 18d is driven by a prime mover 43b such as an internal combustion engine and the power generation is carried out. The electric drive power generation unit connected to the electric power line



1d has the above stated contents and the detail explanation thereof will be omitted. Reference numerals 18, 18a indicate electric drive generators, reference numerals 18b, 18c and 18d indicate generators, and a reference numeral 19a indicates a drive use electric motor of the generator 18c. A reference numeral 26 indicates a pump hydraulic turbine, reference numerals 43a and 43b indicate prime movers such as the drive use internal combustion engine. A reference numeral 100 indicates a condenser used for a power factor improvement of the system load and a power generation wave form adjustment, and a reference numeral 101 indicates a general load means for supplying the electric power using the electric power line 1d.

Fig. 6 is an explanatory view showing an example of a case where to the blower an element for moving the air using a magnet 104 is mounted and in Fig. 6A one element is mounted and in Fig. 6B plural elements are mounted. A reference numeral H indicates an inclined hole in which the magnetic field is strengthen in a wind flow direction and since the oxygen in the air is a paramagnetic substance the air is moved without the energy and the performance of the blower can be heighten. For example, under the magnetic field of 1 Stera, the wind velocity of 0.6 m/s can be obtained. Fig. 6B is an example in which in a magnet 105 plural elements are provided and the move of the air can be further heighten without the energy. A reference numeral 15 indicates an electric motor, a reference numeral indicates a blade and reference numerals 102 and 103 indicate frames. In a case in which the magnet is replaced with an electromagnet,



the similar effects can be obtained.

Fig. 7 shows a wind power generator which carried out the power generation by receiving the wind from a whole periphery and in this generator a wind direction guide 107 is arranged in a surrounding portion of a centrifugal blade 75 and in any wind direction the wind can work validly to the blade. Fig. 7A shows a whole cross-sectional view and Fig. 7B is a cross-sectional view showing a relationship between a blade 75 and a wind direction guide 107. A reference numeral 15a indicates a generator.

Fig. 8 is an inner-rotor type induction motor. Fig. 8A is a cross-sectional structure showing the induction motor having a rotor 113 which is constituted by combination of a rotor 113 formed by a rotor bar 111 with an electromagnet 120, and Fig. 8B is a cross-sectional structure showing the induction motor having a conventional rotary bar rotor 113'. When the electric power is applied to coils wound around in stators 112 and 112' by cords 119 and 119', the rotation magnetic field occurs and the electromagnetic force generates between the current generated in the rotors 113 and 113' and then it works as the electric motor.

Further, a rotor 113 is driven from an outside according to the power source and to the coil 115 wound around in the stators 112 and 112' the voltage occurs in response to the rotation number and to electric power take-in cords 119 and 119' the load such as the resistance is connected and then current flows into and the electric power is supplied. The generation

voltage of the coil is proportional to the magnetic flux density of the air gap between the stator and the rotor and also is proportional to the rotation number. According to the present invention, by the structure of the rotor 113 and by the combination of the electromagnet 120, a suitable power generation system can be obtained.

Next, as to the rotor according to the present invention, hereinafter the iron core structure, the conductive plate, the rotor bar and the winding constitution etc. will be explained referring to the figures. Fig. 9 is an explanatory view showing the rotor according to the present invention and in Fig. 9A1, Fig. 9A2 and Fig. 9A3 show respectively the induction motor in which a notch portion C is provided on an outer peripheral portion and the current having flown the rotor bar 11a flows the conductive plate 126 in which the outer periphery is cut off and the inner peripheral portion of the disc conductive plate 127' in which the electric resistance of the outer peripheral portion is increased and then the activation and the output characteristic are improved.

With this construction, the magnetic resistance is increased by surrounding the ferro-magnetic substance arranged in the both wall sides of the conductive plate 126 and a disc conductive plate 126' and the iron core 134 and the in response to the height of the frequency the current is limited and then an activation characteristic and the output characteristic to the rotation number can be improved. A rotor bar 125 arranged in the iron core inner peripheral portion has the similar

operation to the that of the conductive plate 126 and the disc  
conductive plate 126' and by arranging the ferro-magnetic  
substance 141 in the vicinity the effects can be strengthen.  
The width in the axial direction of the rotor iron core 124a  
5 is formed larger than the axial direction width of the stator  
iron core 112a, the magnetic flux density can be reduced. To  
make the electric resistance in the rotor bar small, the  
electric circuit between the conductive plate 126 provided at  
the central portion and the disc conductive plate 126' and an  
10 end ring 123a is formed short as soon as possible, and then the  
output improvement and the efficiency-up can be improved.

A reference numeral 115 indicates a stator winding, and  
a reference numeral 118 indicates a shaft. A reference numeral  
127a indicates a penetration hole which is provided on an outer  
15 peripheral portion of the conductive plate 126 and the disc  
conductive plate 126' and a rotor bar 111a is penetrated. A  
reference numeral 128 indicates a penetration hole which is  
provided on an inner peripheral portion of the conductive plate  
126 and the disc conductive plate 126' and a rotary bar 115 is  
20 penetrated. A reference numeral 129a indicates a penetration  
hole of the shaft 118a.

Further, as shown in Fig. 9B1, Fig. 9B2 and Fig. 9B3, to  
the both sides of the rotor according to the present invention,  
which is constituted by a rotor bar 111b, an end ring 123b and  
25 a rotor iron core 124, an electromagnetic coil 120b is arranged,  
using the direct current for flowing the this electromagnetic  
coil 120b the direct current magnetic field is formed and using

the alternating current with the single phase or the multi-phase the rotation magnetic field is formed, and the activation characteristic tic and the output characteristic of the rotating machine can be improved. A reference numeral 112b indicates a stator iron core, a reference numeral 115b indicates a rotor iron core, and a reference numeral 118b indicates a shaft. A reference numeral 123b indicates an end ring, a reference numeral 127b indicates a penetration hole of the rotor bar, and a reference numeral 129b indicates a penetration hole of the shaft 118b.

Fig. 10 an example for realizing the required characteristics of the rotating machine by combining the cage type rotor shown in Fig. 9B1 and the coil conductive member according to the present invention. Fig. 10A1 is similar to that of Fig. 9B1 and the explanation thereof will be omitted.

Fig. 10A2 shows a rotor in which a rotor bar 125a is arranged in an inner periphery of a rotor iron core 124c and in an outer peripheral portion a coil 130 is arranged. The activation characteristic and the generator characteristics are coped with the coil 130, and the coil 130 is used mainly for varying widely the characteristic of the near synchronous speed shown in a graph of Fig. 12A. A reference numeral 112c indicates a stator iron core, a reference numeral 115c indicates a rotor iron core, and a reference numeral 118c indicates a shaft.

Fig. 10A3 shows a rotor in which a rotor bar 125a is arranged in an inner periphery of a rotor iron core 124c and

at an outer peripheral portion a coil 130a is arranged and then the activation characteristic and the generator characteristic can be coped with the rotor bar 125a, and the coil 130a varies mainly widely the characteristic in the near synchronous speed as shown in a graph of Fig. 12C. A reference numeral 112d indicates a stator iron core, a reference numeral 115d indicates a rotor iron core, and a reference numeral 118d indicates a shaft.

Fig. 10A4 shows an example, with a similar constitution shown in Fig. 10A3, in which a thickness of the rotor iron core 124d is formed thicker than a thickness of the stator iron core 112e. The characteristic in the near synchronous speed is varied widely with the coil 130b as shown in a graph of Fig. 12C and the hangover effect of the iron core is aimed and then the whole output characteristic and the efficiency improvement can be attained. A reference numeral 112e indicates a stator iron core, a reference numeral 115e indicates a stator winding, a reference numeral 118e indicates a shaft and a reference numeral 125b indicates a rotor bar.

Fig. 10A5 and Fig. 10A6 show examples in which rotor bars 125c and 125d arranged in the vicinity of the inner periphery of the rotor iron cores 124e and 124f and single or plural conductive plates 126b and 126c are put side by side. Reference numerals 112f and 112g indicate stator iron cores, reference numerals 115f and 115g indicate stator windings, reference numerals 118f and 118g indicate shafts, and reference numerals 130c and 130d indicate coils.

Further, in from Fig. 10A2 to Fig. 10A6, it is possible to replace the rotor bar with the coil. To the coil the voltage having a phase different 90 degrees with the rotor secondary induction voltage is applied and the power factor of the induction generator can be varied voluntary, as a result in response to the load connected to the power line the power factor balance can be taken validly. Further the direct current is flown to the coil and the direct current electromagnet is formed, than it can use to the synchronous motor and the brushless motor, the linear motor, and the pancake type motor.

Fig. 11 is an explanatory view showing an example of a rotor structure for preventing the deformation and the fly out according to the centrifugal force acted on the iron core accompanying with the rotation in a case the rotor iron core is divided to insert the magnets. Fig. 11A shows a cross-sectional view of the stator and the rotor of the rotating machine to which the present invention is applied. A reference numeral 112h indicates a stator iron core, and a reference numeral 115h indicates a stator winding. In the rotor, the rotor iron core 124h is separated in a central portion by a conductive plate 126d and a reinforcement plate and to the both side faces of the rotor iron core 124h, an end ring 123c is arranged and to an outer peripheral portion a rotor bar 111d is arranged.

In Fig. 11B, to the end ring 123c a ring shape projection 131 is provided and to the iron core 124h a ring shape groove 135 which engaged with the projection 131 is provided. A

reference numeral 127c indicates a hole which is provided on the divided iron core 124h in which the rotor bar 111d penetrates, and a reference numeral 134 indicates a spacer for supporting and fixing the divided iron core 124h. Fig. 11C shows an example  
 5 in which a conductive plate 126d constituted to separate the divided iron core 124h is utilized as a reinforcement plate for preventing the deformation and the fly out by the centrifugal force. To the both faces of the conductive plate 126d the projection pins 136 are provided, to the divided iron core 124h  
 10 plural holes 133 for engaging the pins 136 are provided. A reference numeral 127s is a hole in which the rotor bar 111d provided on the conductive plate 126d penetrates.

Fig. 12 are graphs showing the variation (the change) of the characteristics of the various kinds induction generators. Fig. 12A shows the characteristic changes of the generator due  
 15 to the resistance change of the conductive substance of the rotor. The resistance becomes large in proportion to from a graph c1 to a graph c5. Fig. 12B is a graph showing the characteristic in which the frequency of the exciting use power  
 20 source is varied. The power source frequency becomes large in proportion to from a graph c6 to a graph c8.

Fig. 12C is a graph showing the change in the characteristics in which the voltage of the exciting use power source is varied and the characteristic in the near synchronous  
 25 speed is varied widely. A graph c10 is one of the condition before the characteristic change and a graph c9 is one in which the voltage having the reversal phase to the current for flowing

the rotor winding is added, under the condition where the rotation number before the alternation is lowered the characteristic can be moved in parallel. A graph c11 is one in which the voltage having the same phase to the current for flowing the rotor winding is added, under the condition where the rotation number before the alternation is raised the characteristic can be moved in parallel.

Fig. 13 is an example in which the widths of the rotor iron cores 124i, 124j and 124m are extended over than the axial direction widths of the stator iron cores 112i and 112j and the hangover portion rotor bar 111e and the winding 130e can be used effectively, and then the characteristics such as the performance improvement and the efficiency improvement can be attained. Namely, the diameters of the end ring 123d and a coil end E of the rotor winding 130e are formed small as possible, for example less than 1/3 of the outer diameter of the rotor, and they are arranged in the vicinity of the shafts 118i and 118j.

As shown in Fig. 13A2, the magnetic field formed by the current for flowing the rotor bar increases the magnetic field in the air gap portion. To ensure the magnetic field formation the iron cores 124j, 124k and 124 formed by the sintering and laminated layer are provided. The magnetic flux formed by the current I passes through to the outside portion once and passes through the iron cores 124k and 124n and returns to the air gap from the adjacent pole iron core. Reference numerals 115i, 115j indicates stator windings, a reference numeral 126e is a



conductive plate which works the same role of the deep groove rotor bar and the end ring 123d.

Fig. 14 is an example in which an axial direction length of the rotor iron cores 124o and 124r is formed longer than the length of the stator iron cores 112k and 112m and the characteristic improvement and the efficiency improvement can be obtained. Fig. 14A1 and Fig. 14A2 are examples in which the stator iron core 112k is extended to the hangover rotor bar 111f and the characteristic improvement is obtained by an additional action between the current I for flowing the hangover rotor bar 111f and the stator winding 115k. Reference numerals 124p and 124q are iron cores which are made by the sintering material and have the small eddy loss. A reference numeral 118k indicates a shaft, and a reference numeral 126f indicates a conductive plate.

Fig. 15 is a rotary machine in which in the windings of the stator and the rotor slot-less cylindrical shape iron cores 112n and 124u are fixed to the coils 115n and 130f using an adhesive agent etc. and then the cogging torque can be made small and the activation torque can be made small and the efficiency can be improved. To not deform or not to peel off the fixed coils 115n and 130f during the rotation time, using a fastening projection 151 provided on cylindrical shape holding members 150 and 150a the hole provided on the cylindrical iron cores 112n and 124u are utilized. To the adhesive agent 160 magnetic substance powders 160 are immersed.

Fig. 15A1 is an explanatory view showing an example in

which to the stator core a slit-less iron core is applied and Fig. 15A2 is an explanatory view showing an example in which to the rotor core a slit-less iron core is applied. A reference numeral 111g indicates a rotor bar of a cage type rotor and a reference numeral 123s indicates an end ring of the cage type rotor. Reference numerals 118n and 118o indicate shafts and a reference numeral 112o indicate a stator iron core and a reference 115o indicates a stator iron core. Fig. 15A3 is a view in which the winding is developed in a circumferential direction. Fig. 15A4 is a cross-sectional view in which Fig. 15A3 is seen from a side face and the relationship between the cylindrical iron core 112, the coil 115 and the holding member 150 and the fastening projection 151 is shown..

Fig. 16 shows an outer-rotor type generator. Fig. 16A is a cross-sectional view showing the generator having a rotor 202 which is constituted by magnets 214 or electromagnets 242 and 243 and a combination thereof according to the present invention, and Fig. 16B is a cross-sectional view showing a generator having a conventional cylindrical type magnet rotor 202'.

Next, the magnetic flux improvement counter-measurement in the air gap according to the magnets will be explained referring to Fig. 17 and Fig. 18. Fig. 17 is an example showing the outer-rotor type generator and Fig. 18 is an example showing the inner-rotor type generator. In a cross-sectional figure shown in Fig. 17A, the generator is constituted by a power transmitting outer frame 210 in which a rotor material is made

of a non-magnetic substance, six divided iron cores 213 and six magnets 214. In this case a space sandwiched by the stator, a portion and b portion of a side outer frame, the outer frame 210 and the iron core 213 is constituted by a non-magnetic substance. Since the twice times of the radial direction length of the magnet 214 is made larger than the circumferential direction length of one pole part of the air gap portion, the magnetic flux in the air gap portion can be made larger than the magnetic flux of the magnet 214.

Fig. 18B is an example in which the magnets 214a and 214b having the different strength are inserted into a slit. Fig. 18C is an example in which a cross-section of the magnet is a trapezoid shape. Fig. 18D is an example in which two magnets having the same strength are increased per one pole. Fig. 18E is an example in which two kinds magnets are used and a main magnet 214 determines the magnetic field in the air gap and a magnet 214' adjusts minutely the magnetic field. Fig. 18F is an example in which to the conventional cylindrical magnet the magnet according to the present invention is combined.

Fig. 18A - Fig. 18F show the inner-rotor type generator and have a reversal structure of the outer-rotor type generator shown in Fig. 17 and since the structure thereof is basically to the same one the explanation thereof will be omitted.

Fig. 19 is a plan view showing an example of the divided iron core part of the rotor of the above stated outer-rotor type generator and facing to the air gap between the stator three slots 231 are provided.

Fig. 20 is an example in which using the structure shown in Fig. 19A to the rotor of the outer-rotor type generator the cage type rotor is formed. The structure of a cage type rotor part is shown in Fig. 20B and Fig. 20C and is made of the  
 5 conductive member such as aluminum and brass and by two side sheets 218 and plural bars 219 the rotor is formed integrally using the caulking and die casting. When the magnet according to the present invention is extended to the axial direction, in a case shown in Fig. 20B, the iron core is separated by the  
 10 side plate 218.

In Fig. 20C, the radial direction length of the side plate 218 is formed small as possible, the cross-section thereof is formed same and is extended to the axial direction. The side plate is arranged in the inner peripheral face of the magnet iron core (in the case of the inner-rotor type generator, to  
 15 the outer peripheral face thereof), to concentrate the magnetic flux from the magnet which is extended to the both sides and the electromagnet to the stator air gap and further the side plate is arranged with a stepwise part 232, which is provided  
 20 to prevent the leakage from the side face of the stator, of the rotor iron core and thereby the affect to the magnetic path can be lessened.

Fig. 20D is an example in which only the magnet 214 is extended in the axial direction of the rotor and Fig. 20E is  
 25 an example in which electromagnets 242 and 243 are added to the both sides of the rotor magnet 214 faced with the stator 212. In this case, a magnetic flux leakage gap 252 of the

electromagnet 242 and a magnetic flux leakage gap 253 of the electromagnet 243 are provided to work validly to the prevention of a short-circuit of the magnetic flux to the stator.

Fig. 21 is an example of a case where there is a limitation of the space of the magnetic pole arrangement of the electric motor and the generator as shown in Fig. 17F, utilizing validly the limited magnetic pole space, a whole face or a part of the solid face the magnets are arranged organically and to the air gap portion the magnetic flux can be concentrated at the maximum. For example, a magnet 214a'' and a magnet 214d arranged to the axial direction magnetic pole face can be formed a ring shape and can be formed an integral structure. Further, by combining a magnet 214c or a magnet 214b'', a cap shape can be formed.

The magnet 214c is a cylindrical shape magnet which is arranged in the outer peripheral portion of the magnetic pole and on the periphery thereof an iron core 213a for forming the magnetic path of the magnetic flux is arranged. To an outer side of the magnet 214d an iron core 213b is arranged and the magnet 214d is worked validly. All magnets are settled and arranged to concentrate the magnetic flux to the air gap portion and have the polarity of the respective magnet of N and S shown in figures.

Fig. 22 and Fig. 23 are explanatory views showing a donut shape electromagnet structures which are enable to combine with another magnet and electromagnet. Fig. 22 shows an example in which the magnet poles are two poles and Fig. 23 shows an example in which the magnet poles are six poles. Next, the

detail explanation of the electromagnets will be explained referring to Fig. 22. In Fig. 22A and Fig. 22B, to an outer periphery two magnetic poles of N and S are formed, and when they are used as the rotor it can apply to the inner-rotor type generator.

Further, in the case of the combination with the another magnets and electromagnets, by adjusting the other part magnetic poles, they are carried out on the outer peripheral face. The adjustment of the magnetic pole is carried out by varying the magnetic polarity of the direct current power source from terminals of a and b of a coil 260a. A reference numeral 250 indicates a gap for preventing the short-circuit of the magnetic fluxes of N pole and S pole. An electric angle of a cut portion shown in Fig. 22B is requested by a following formula.

$$\text{cut portion electric angle} = 180 \text{ degrees} - \{2 \times \text{phase number to be excited} / \text{rotor pole number} \times \text{electric motor phase number}\} \text{ degrees}$$

This devotes the improvement of the output efficiency of the electric machine by making the minimum the conversion loss accompanied with the electric pole conversion generated in the coil.

Fig. 22C and Fig. 22D show the structures having the magnetic pole on the inner peripheral face and have the reversal structures shown in Fig. 22A and Fig. 22B. In Fig. 22E and Fig. 22F the magnetic poles are the right face and in Fig. 22G and Fig. 22H the magnetic poles are the left face. Fig. 24 is a

schematic view showing four kind electromagnets of the six pole electric machine and the magnets of the inner and outer rotor. Fig. 24A1 shows an outer periphery magnetic pole type electromagnet, Fig. 24A2 shows an outer periphery magnetic pole type electromagnet, Fig. 24A3 shows a right face magnetic pole type electromagnet and Fig. 24A4 shows a left face magnetic pole type electromagnet. Further, Fig. 24A5 shows an outer-rotor use magnet and Fig. 24A6 shows an inner-rotor use magnet.

Fig. 25 is an example showing a combination of the inner-rotor use magnets and electromagnets and Fig. 26 is an example showing a combination of the outer-rotor use magnets and electromagnets. Herein, the example shown in Fig. 26 will be explained. Fig. 26A is an example in which the magnetic pole is formed with only one outer periphery magnetic pole type electromagnet. Fig. 26B is an example in which one electromagnet is arranged in an interior portion and one magnet is arranged in an outer side. Fig. 26C is an example in which the magnet and the left face magnetic pole type electromagnet. Fig. 26D is an example in which two electromagnets are arranged and Fig. 26I is an example in which three electromagnets are arranged. Fig. 26E and Fig. 26F are examples in which the magnet is combined to the outer face of the electromagnet shown in Fig. 26D and Fig. 26I. Fig. 26F, Fig. 26G and Fig. 26H are examples in which to one magnet or electromagnet two other magnets or electromagnets are combined.

Fig. 27 and Fig. 28 are examples in which the stator of three phase electric machine using three pieces of the two pole

Fig. 29 is an explanatory view showing a structure of two pole electromagnet iron core and shows the structure which is enable to manufacture the iron core using only one manufacturing tool. Fig. 29A shows one winding use outer periphery magnetic pole of the iron core and Fig. 29B shows one winding use inner periphery magnetic pole of the iron core. An iron core 272 forms the outer periphery magnetic pole type and an iron core 273 forms the inner periphery magnetic pole type. Fig. 29E, Fig. 29F, Fig. 29G show examples two winding use outer periphery magnetic pole of the iron core and Fig. 29H, Fig. 29I, Fig. 29J show examples two winding use inner periphery magnetic pole of the



Fig. 30 is an explanatory view showing an iron core  
5 structure to lessen the eddy current loss of the alternating  
current electromagnet. Fig. 30A and Fig. 30B show the iron core  
structures in which the sintering member and the iron powder  
are solidified by the bonding material. Fig. 30C and Fig. 30D  
show examples of a combination of an electromagnetic steel plate  
10 281b with an iron core 281a in which the sintering material and  
the iron powder are bonded by the bonding material. Fig. 30E  
and Fig. 30F show examples of a combination of an  
electromagnetic steel plate 282b with an iron core 282a which  
constitutes a squeezing structure of a thick iron plate having  
15 slits 283.